RESEARCH HIGHLIGHTS

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COOLING RATES OF HOUSES DURING EXTENDED POWER FAILURES

Introduction

It is a concern for most Canadians if they leave their home for extended periods in winter: "What happens if the power goes out?" And, during winter storms when everything goes dark, we are apt to wonder "How long will the house keep warm?" It turns out that, in most cases, houses will stay above freezing point longer than expected.

If the furnace stops operating, the house will start to cool immediately. The colder it is outside and the higher the indoor air temperature, the faster the rate of cooling. Assuming that the indoor temperature starts around 20°C, it is not surprising that in the first several hours, or overnight, the indoor air temperature can drop to 14°C or 15°C. Homeowners with setback thermostats will notice overnight reductions of this magnitude. From that point on though, cooling occurs more slowly. Part of this is due to the fact that the temperature differential of indoors to outdoors is now lower; and part is due to the thermal mass of the house. While the air may cool quickly, the material that makes up the house–concrete, wood, ceramics, gypsum, and furnishings–will take longer to lose their temperature. As well, in most houses with basements or crawl spaces, the earth beneath and around the house has a high thermal mass and does not change temperature quickly. If the soil temperatures are at 5-10°C, and they rarely drop below this except near the surface, then the soil will be adding heat to the house interior as house temperatures drop. A third factor is the incidental gains from the sun or occupants. The greater the south facing glass, and the sunnier the weather, the more solar heating will increase house temperature.

Research Program

Some of the best information on house cooling rates came from eastern ice storm of 1998. CMHC engaged a contractor to measure temperatures in houses that had been without heat and occupants for many days. In the Saint-Jean-sur-Richelieu part of Quebec, the electricity distribution system had failed on January 6. The local authorities were checking the houses on a daily basis. The contractor received permission to enter 31 of these houses. Between January 18-23 (12-17 days after the power had failed), he measured house air temperatures and surface temperatures in the basement. He also roughly estimated house size and insulation level, and recorded the date of construction. The houses represented a wide range of size, type (bungalow, two storey, small multifamily), and age (1910-1994). The mean outside temperature during this period was between -7 and -8°C, with daytime highs of up to 3°C. This is warmer than usually for midwinter conditions in this area but still significantly cold. The temperature was as low as -23°C during that period.

Results

None of the air or surface temperatures in the 31 houses inspected had fallen below 0°C. Typically, basement air temperatures averaged 7.4°C. First floor temperatures were slightly lower. The data is listed in the following table.

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Table 1: Temperature data (°C)

House I.D. no.	Mean basement floor temp.	Mean basement wall temp.	Air temp. basement	Air temp. first floor	Air temp. second floor
1	6.5	7.2	8.2	7.6	6.0
2	4.2	4.2	4.6	4.8	4.5
3	5.9	6.1	6.1	6.2	-
4	7.4	7.9	7.4	7.2	-
5	6.2	6.5	8.5	7.2	-
6	6.5	7.1	8.7	6.6	-
7	3.7	5.3	7.2	2.6	4.3
8	5.8	6.5	5.5	5.5	-
9	4.5	5.2	4.6	6.4	-
10	5.8	6.7	6.4	6.7	6.7
11	10.0	10.8	13.4	11.3	10.3
12	4.7	6.7	10.3	7.3	5.0
13	6.0	6.4	6.4	5.9	4.2
14	6.0	6.6	9.4	8.4	8.2
15	7.3	7.7	8.6	8.5	-
16	5.6	6.2	9.4	8.3	-
17	5.5	6.6	8.9	-	6.1
18	3.7	4.2	5.0	4.9	
19	4.2	5.0	4.9	5.6	-
20	9.0	9.6	10.6	10.0	-
21	6.1	6.9	7.2	7.4	-
22	5.8	6.4	9.3	8.2	-
23	4.8	5.0	-	8.5	-
24	6.6	6.8	7.4	6.5	-
25	2.3	3.5	4.1	3.6	-
26	6.0	6.4	7.7	6.6	-
27	4.4	4.7	7.0	6.4	-
28	5.6	5.9	4.7	4.2	-
29	5.8	6.2	6.4	6.3	-
30	7.8	6.1	6.6	4.8	4.7
31	6.3	7.4	7.9	7.1	5.9

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Implications

The measured data in these 31 houses should be reassuring for most homeowners. If the power fails during winter, the house may take days or weeks to fall below freezing, depending upon the severity of the weather outside. Therefore, the need to protect water systems, valuable furniture, pets or plants can be handled over several days, and not several hours. House temperatures will drop quite quickly to levels that could be uncomfortable (or dangerous for sensitive populations), but the house may take many days to arrive at freezing temperatures. In very cold temperatures (for example, -30°C), high winds or houses without basements, the rate of cooling will be much faster than observed in the southern Quebec houses of this study.

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